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OBSERVATIONS

ON THE

PHYSIOLOGICAL AND THERAPEUTICAL
EFFECTS

OF

Galvanization of the Sympathetic.

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GALVANIZATION OF THE SYMPATHETIC.*

THE attention of the profession was called to the therapeutical action of the galvanic current on the cervical ganglia of the sympathetic by Professor Remak,† of Berlin, who was the first to note the fact, now well recognized among electro-therapeutists, that contractions of the muscles of one or both of the upper extremities may be produced by placing the positive pole in the auriculo-maxillary fossa, just anterior to the ascending ramus of the lower jaw, and the negative by the side of the sixth cervical vertebra. The theory of Remak, that these contractions, to which he gave the name of “*diplegic*,” were caused by irritation of the superior ganglia of the sympathetic, was confirmed by Fieber,‡ by experiments on animals in whom the sympathetic was exposed, and subjected to the action of the electric current.

Strong currents—from twenty to forty elements—are usually, though not always, necessary to produce these contractions. The contractions may be of various degrees, from mild drawing, with scarcely perceptible oscillations, to violent movements resembling chorea. They may appear in the interossei or in the muscles of the arm or forearm of one or both sides. They may also appear in other positions of the electrode than the one described. From one to five minutes are usually necessary to excite them, and they may continue for a few moments after the application has ceased.

There are two obvious reasons why galvanization of the sympathetic in the living man should not have the same marked effect as on animals when the ganglia are exposed.

* The greater portion of this essay appeared in the *Psychological Journal* for July, 1870. In its present form, with additional experiments and cases, it is extracted from our work on *Medical and Surgical Electricity*, now in press.

† Application du courant constant au traitement des neuroses. Paris, 1865.

‡ Die diplegischen Contractionen nach Versuchen an Menschen und Thieren. Berlin, 1866, pp. 21, 22, 23.

First. The anatomical position of even the most accessible ganglia is such that the current can only be applied to them by first traversing other tissues. It is therefore impossible for them to feel the full power of either pole.

Secondly. The sympathetic cannot be electrized without at the same time electrizing other important parts of the central or peripheral nervous system. Thus, in the first method (see fig. 1), the upper portion of the spinal cord, and in the second method, the pneumogastric, is included in the circuit. In all the other methods either the brain or spinal cord must be more or less affected.

But although exclusive localization of the current in any of the sympathetic ganglia of the living man is impossible, yet the important physiological and therapeutical results that arise from applying the current, especially the galvanic, through those parts in which the ganglia are most accessible, show conclusively and in a most interesting manner that these ganglia are directly affected, and that the difference in the effects of such applications on the living and on the exposed animal are merely differences of degree.

In order to determine the physiological effects of galvanization of the cervical sympathetic, we have experimented considerably on ourselves and others in comparative health. The applications were made in the manner above described in figure 1, usually with a modification of Stöhrer's battery, or with a number of Smee's elements. The number of cells used ranged between ten and twenty-five, and the length of the séances was from two to five minutes. The effects experienced from these applications were as follows:—

1. *A slight feeling of drowsiness.*—This sometimes began to be perceptible shortly after the electrodes were applied, increased up to a certain point, and continued for some little time after the séance was over. In many cases it is not observed until the lapse of five or ten minutes after the séance. The feeling, which was by no means constant, was usually so slight that it might not have been observed, had we not in our experiments kept closely on the watch for every sensation experienced during or just after the application.

On the accepted theory that a state of cerebral anæmia pre-disposes to sleep, we should reason, *à priori*, that electrization of the sympathetic ought to induce a feeling of drowsiness, since it unquestionably diminishes the current of blood in the brain, and experimentally we have found that it does thus induce a slight and temporary disposition to sleep, although this result is probably far less marked than it would be if, without injury to the living subject, the application could be made directly to the ganglia.

Dr. Hammond* has found that galvanization of the sympathetic caused contraction of the vessels of the brain, as may be demonstrated by examining the retina with the ophthalmoscope during the application.

From observations that we have made at different times and by various methods of application, it would appear that anæmia of the retina is not a uniform or necessarily an immediate result of galvanization of the sympathetic, but that hyperæmia may sometimes be temporarily produced; and in other cases no change in the vascular condition of the retina is observed, beyond a slight enlargement of the veins.

In order to determine this question, we have instituted a number of experiments on our own persons, with the aid of several ophthalmologists.

The positive electrode, connected with a galvanic current of twenty Stöhrer's cells, was placed in the right auriculo-maxillary fossa, and the negative over the sixth and seventh cervical vertebræ. Dr. St. John Roosa examined the retina with the ophthalmoscope just before, during, and about five minutes succeeding the applications. During the passing of the current, Dr. Roosa observed that the arteries of the retina *increased* in size, and that more vessels were brought into view. The applications were continued from two to five minutes. On examining the condition of the retina, about five minutes after the application had ceased, Dr. Roosa observed a marked *decrease* in the size and the number of the arteries. It was evident that the secondary effect of the galvanization was to produce anæmia of the retina, since it presented fewer and smaller blood-vessels than before the appli-

* Journal of Psychological Medicine, April, 1870, p. 249.

cation. The experiment was repeated on both of us, and on both sides, and with substantially the same results.

Dr. Roosa subsequently repeated his examinations at the Manhattan Eye and Ear Infirmary, when a galvanic battery of smaller Smee's elements was used, and the negative pole was placed in the auriculo-maxillary fossa. He observed the same changes in the condition of the retina, though they were not fully as marked as in the preceding experiments.

Dr. Loring, who examined the retina with the ophthalmoscope before, during, and after the passing of the current, observed a marked increase in the size of the veins, but no change in the size of the arteries.

The same examination of the retina was afterwards made by Dr. Hackley, at our office. A feebler current was used than in the former experiments. He noticed a slighter enlargement of the veins, and also a slighter change in the arteries, but no decided anæmia after the application.

When the positive electrode was placed in the auriculo-maxillary fossa and the negative on the deltoid muscle of the opposite side, Dr. Hackley observed a very slight contraction of the arteries without any primary hyperæmia.

We had supposed that the enlargement of the veins observed by Drs. Loring and Hackley might be due to simple pressure of the electrode on the jugular vein, but Dr. Hackley failed to discover any change in the appearance of the veins, while very firm pressure was made on the auriculo-maxillary fossa by an electrode not connected with the battery.

In order to determine whether the *faradic* current could produce any effect on the vascular condition of the retina, we directed as strong a faradic current as could be borne through the cervical ganglia, in the manner described in Fig. 1. Dr. Hackley examined the retina before, during, and after application. At first no change was observed. After the séance had been continued twice as long as is usual when the galvanic current was employed, slight congestion of the retina was observable, which soon disappeared after the close of the application.

This observation, taken in connection with the clinical fact that

general faradization is followed by the disposition to sleep and equalization of the circulation, as well as by changes in the pulse that are observed from galvanization of the sympathetic, shows pretty conclusively that the practical difference between the two currents is mainly one of *degree*.

Our observations would seem to show that the effects of galvanization of the cervical sympathetic on the retina, like the therapeutical effects, vary more or less with the strength of the current, the length of the application, and the position of the electrodes.

The subject is worthy of diligent and systematic investigation.

If it shall be established by further experiments that anæmia of the retina follows galvanization of the cervical sympathetic, and if it be conceded that the vascular condition of the retina uniformly partakes of the vascular condition of the brain (a question that is not yet fully settled), then the slight tendency to sleep, sometimes observed after this method of treatment, is satisfactorily explained. Since absolute and exclusive localization of the current in the sympathetic is impossible, the effects observed by ourselves are also not unlikely modified by the effect of the current on the upper portion of the spinal cord.

The same remark will apply to the therapeutical effects of these applications.

2. *A feeling of warmth through the system.*—This was not a constant symptom, though it was oftentimes very decided. A strong current may cause sensible perspiration. The extent to which this was felt was manifestly dependent on the strength of the current and the length of the application. It was usually felt but a short time after the séance was completed. We have observed this effect more frequently and more markedly in the susceptible and nervous than in the cold and phlegmatic, and most frequently in pathological cases.

3. *A marked effect on the pulse.*—It was sometimes accelerated, but more frequently lowered, two, three, four or more beats.

In order to determine the effects of electrization of the sympathetic on the pulse, we made the examinations immediately before and immediately after the applications. Every precaution was

taken to avoid error, by allowing an interval of rest before the sitting, in order to give time for the subsidence of the pulse to its natural condition, from any excitement that it may have received from the exertion of walking or the labor of partially disrobing. In cases of doubt the whole minute was counted, in some instances several times in succession. A patient unaccustomed to the sensation produced by the electric current, or to the *modus operandi* of its employment, might experience an acceleration of the pulse from simple mental excitement, not only prior to or at the commencement of the sitting, but also during or after the application. Error from this cause was in our cases manifestly impossible, and all the others on whom we experimented with a view to obtain physiological results were so well familiarized to the medical employment of electricity that they would receive any treatment proposed with cool indifference. In order still further to guard against error, and at the same time to observe the continuance or permanency of the effect of the experiments, we repeated, in some instances, our examinations of the pulse at intervals of fifteen minutes or half an hour after the sitting was over.

A corroborative evidence that these changes in the pulse were due to the action of the current, and not to mental excitement, is found in the fact that, after an interval of five, ten, or fifteen minutes, the pulse returned to its original condition.

These changes in the time of the pulse were also accompanied by perceptible changes in its character, which, if careful sphygmographic observations had been made, might perhaps have been reduced to some general law.

Eulenburg and Schmidt (quoted by Althaus) found that when the positive pole of from 20 to 40 of Daniells' elements was placed at the *manubrium sterni* and the negative pole in the auriculo-maxillary fossa, the pupil of that side was at first slightly dilated and afterwards contracted. These changes in the pupil are not uniform in their appearance. In some cases they appear at once after closing the circuit, and in others after the lapse of half a minute or minute, and in others still, after interruptions. These phenomena are liable to many variations, according to the strength,

length, and locality of the applications. If an electrode is placed in the auriculo-maxillary fossa of each side, the changes in the pupil occur on both sides, but are more marked on the side on which is the negative pole. The same application, continued for some time with a strong current, reduced the normal pulse from 4 to 16 beats a minute, and the pathological pulse even more, diminished the tension in the carotid and vertebral arteries, and markedly altered their sphygmographic tracings. The same observers found that galvanization of the spine also diminished the beats of the pulse.

PATHOLOGICAL CASES.

Paralysis of the inter-ossei of the left hand—Diplegic contractions on galvanization of the sympathetic—Some improvement.

CASE 1.—Mr. P., afflicted with paralysis of the extensor muscles of all the fingers of the right hand, was directed to us by Dr. J. J. Crane.

The patient had observed some slight loss of power in the affected members for more than a year previous, but was unable to ascribe any cause other than a violent wrench to the hand, that was followed by several burseæ. A dozen applications of the galvanic current resulted in some very slight improvement in the condition of the paralyzed muscles. The so-called diplegic contractions in the diseased muscles were readily observed on galvanization of the cervical sympathetic. At first these contractions were induced only when a current of considerable intensity was used, but at each subsequent application less tension was required, until an exceedingly weak current was sufficient to produce the phenomenon. The patient somewhat improved under treatment.

Attacks of nausea and vomiting—Recovery under galvanization of the sympathetic, after failure of general faradization.

CASE 2.—Mr. S., aged 40, had complained of frequent attacks of nausea, that occasionally were accompanied by vomiting. The patient was of slight build, and of a thoroughly nervous organization. There were no evidences of organic disease either in the history of the case or in the special character of the symptoms. The attacks came on usually in business hours, and could not unfrequently be referred to mental anxiety. A strong evidence that the disease was mainly functional in its character was that on Sabbath days, when the patient did not go to the office, and was free from business cares, he was also free from the attacks.

Ordinary treatment, both by medication and by electricity, carefully and perseveringly employed by the usual methods, had failed to give substantial relief. As a last resort, we resolved to experiment with applications localized in

the cervical sympathetic. The results were immediate and favorable; from the first application he began to improve, and in three weeks he regarded himself as cured.

This experiment was eminently a fair one, since it was tried alone, unaided and unimpeded by other remedies, immediately after other treatment, even that by electrization, had failed.

Myelitis—Tenderness over the superior cervical ganglion, and unusual sensitiveness to the faradic current—Disappearance of sensitiveness under general faradization.

CASE 3.—A lady of sixty years of age had suffered for three years with paraplegia, resulting from myelitis; was found to be extremely sensitive even to the faradic current when applied over the superior cervical ganglion. This sensitiveness was transmitted to the side of the sixth cervical vertebra, even though the other pole (which is usually applied to this place) was at some distant and indifferent point. This sensitiveness amounted to absolute pain when a current even of moderate strength was employed, and would probably have been still more marked under the influence of galvanization. This phenomenon, which we have never before observed in any case either of health or of disease, is probably to be explained by a peculiar and abnormal sensitive condition of the sympathetic. This probability is enforced by the results of the treatment and the subsequent history of the case: in the course of three applications this peculiar manifestation of sensitiveness entirely disappeared, so that it could not be evoked even under the influence of a current of considerable strength. At the same time the patient rapidly improved, both in her ability to walk and in her general condition, under the combined influence of central and peripheral applications.

The interesting point in the case is, that with the manifestation of improvement there was a diminution, and finally a disappearance, of the peculiar sensitiveness of the sympathetic. That in many and diverse cases of disease the cervical sympathetic may be positively and even painfully sensitive to pressure on the application of the electric current, and that this sensitiveness may disappear with the improvement of the patient, we have observed in a number of instances. Benedikt* has observed tenderness in the region of the cervical sympathetic in a variety of morbid conditions.

In that very frequent and obstinate malady, "sick-headache,"

* See Elektrotherapie, passim.

for example, we have observed in a number of instances that on the affected side the cervical sympathetic is markedly sensitive to pressure, and that this sensitiveness persists during the attack and disappears with the subsidence of the pain. This phenomenon, which, we believe, has not before been pointed out, can sometimes be readily verified by making firm pressure in the direction of the superior cervical ganglion during the height of an attack of hemicrania.

Hemiplegia—Relief of injection of conjunctiva by galvanization of sympathetic.

CASE 4.—The efficacy of galvanization of the cervical sympathetic, in reducing injection of the conjunctiva, was well illustrated in the case of a gentleman of 60 years, who was suffering from hemiplegia of the left side. He was attacked six months before we saw him, and for three months subsequently had been able to walk only with difficulty. His face had been somewhat distorted and there had been slight ptosis. In the affected eye there was a feeling of roughness, as though a grain of sand were beneath the lid, owing to a decided and persistent injection of the conjunctiva. Under various methods of applying electricity the patient slowly but manifestly progressed, but the injection of the conjunctiva with the harassing sensation of roughness yet remained. We now resorted to galvanization of the cervical sympathetic. This treatment, faithfully carried out, resulted in some general improvement, but the effect chiefly observed was a diminution, and ultimately an approximate cure, of the chronic injection of the conjunctiva, and the distressing sensation that accompanied it was entirely removed.

The result in this case was of special interest and peculiarly suggestive, since it seemed to confirm the deductions of physiological experiments, on the effect of electrization of the cervical sympathetic in causing contraction of the blood-vessels of the cerebrum.

Complicated case of nervous and uterine disease—Overpowering drowsiness, caused temporarily by short galvanization of the superior cervical ganglia.

CASE 5.—A lady past middle age (sent to us by Dr. Wey), who had been nearly all her life an invalid, suffering at first from uterine displacements with complications, and latterly from neuralgia of the head of the right thigh, was treated for more than two months by powerful faradic currents, variously applied to the spine and to the affected limb, without at any time experiencing any unpleasant or peculiar effects aside from a general weariness for a short period after each application. She had indeed become so thoroughly accustomed to the ordinary electrical applications as to be above the need of special caution or watchfulness in treating her. On one occasion, when she was in about her usual condition, we

galvanized the cervical sympathetic with a current of moderate strength from fifteen elements. In four minutes from the beginning of the séance she began to feel a sensation of drowsiness that was overpowering, amounting almost to faintness. Somewhat alarmed by the suddenness and violence of the symptom, we cut short the application. The drowsiness was not only so extreme as to be disagreeable, but was accompanied by a sensation of nausea and vertigo. The patient was allowed to rest, and in half an hour the unpleasant symptoms departed, leaving behind only a sense of extreme weariness. Cases of such exceeding susceptibility of the cervical sympathetic are, we believe, exceptional; and, with becoming caution, these temporarily disagreeable results can always be avoided by making the first tentative applications with a very moderate current, and of short duration. It is probable that if other cases had been treated as long as in the present instance, similar sensations might have been experienced.

Progressive muscular atrophy in muscles of left hand—Rapid and extraordinary acceleration of the pulse after galvanization of the sympathetic—Subsequent improvement under the same treatment.

CASE 6.—A lady of 20 years of age, affected with muscular atrophy of the left hand, that was gradually extending to the left finger of the right hand. The atrophy of the inter-ossei muscles was so complete that the hand had become a typical illustration of the so-called claw-hand, as described by Duchenne. The electro-muscular contractility and sensibility of the affected muscles was completely destroyed, and even the adductors of the thumb reacted only to a very powerful current. The hand was always exceedingly cold. The general health of the patient was apparently good, and the nutrition was quite well preserved.

After the patient had been for some time treated by peripheral faradization, we resorted to galvanization of the superior cervical ganglion of the right side. Although muscular atrophy is one of the conditions in which dipleptic contractions have been frequently observed, yet in this case they did not appear. The pulse, taken just before the séance, was found to be 92. The application lasted between two and three minutes, and, while the electrodes were in position, no special effect was observed. Two minutes after the application the pulse, which before was 92, was found to be 130, and the hand, which was before cold, was found to be hot, and the face was flushed.

The patient soon left the office, and on her next visit reported that the febrile condition excited by the current was of but short duration.

In this case the sympathetic must have been in a condition of abnormal irritability or of actual disease, since in health such effects on the pulse are not produced even by prolonged applications. This case is of value, as tending to confirm the theory that progressive muscular atrophy is in some way dependent on, or associated with, disease of the sympathetic.

Anæmia with great debility—Paretic condition of muscles of hand—Immediate effect of galvanization of sympathetic.

CASE 7.—A gentleman, aged 45, became so exhausted by protracted disease that he was scarcely able to raise his arms to his head without assistance, and could not entirely close his fingers. The paretic condition of the muscles was evidently functional rather than organic. After other methods of employing electricity—central and peripheral, with both galvanic and faradic currents—had accomplished for him all that was possible, and the patient, though much benefited, had ceased to make progress under their influence, we began to localize the galvanic current in the cervical sympathetic. The immediate effect was to enable him to close his hand, and the séance was also followed by a sense of exhilaration that other forms of application had failed to produce. The faradic current, experimentally employed in precisely the same way, failed to exhibit any such effects. The relief, however, was mostly temporary; on the day following the applications he usually relapsed pretty nearly to his original condition. The treatment, continued for six weeks, caused decided amelioration that gave every hope of permanency; but, as is so frequently the case, the improvement stopped short at a certain point, beyond which it refused to be urged.

The application of electricity to prominent cervical ganglia is an interesting and suggestive, though not yet a well-defined auxiliary to diagnosis. The very decided tenderness that is revealed on electrization of the cervical ganglia, and occasionally of the solar plexus, indicates some disease either of the sympathetic or of some other portion of the system, but does not declare the precise nature or locality of the morbid condition. This tenderness—which is sometimes felt under any form of external pressure—has been observed in nervous dyspepsia, rheumatic gout, locomotor ataxy, muscular atrophy, neuralgia, myelitis, and during attacks of sick headache. The diminution of this morbid tenderness under treatment is usually accompanied by improvement in the condition of the patient. The relation of the so-called “diplegic contractions” to pathology or therapeutics is not yet determined.

The effects of faradization of the cervical sympathetic are not as decided as those of galvanization. That general faradization, however, does affect the sympathetic to a certain extent, seems to be pretty well established both by clinical experience and by its observed effects on the pulse.

To lay down precise and exhaustive indications for the use of galvanization of the sympathetic is, in the present state of our

knowledge of the physiology and pathology of this system, obviously impossible; the best guide to these indications is experience. The general indications for the use of this method of treatment to which experience would seem to point are these:—

1. Cases in which the sympathetic is itself diseased. Paralysis of the sympathetic, though not a frequent affection, is nevertheless one that is believed to occur, and to be quite amenable to galvanization. The sympathetic has also been found diseased in progressive muscular atrophy.

2. Cases in which the sympathetic is in a condition of abnormal irritability, a condition which is revealed by the effects of galvanization, and especially by the diplegic contractions. This condition is most frequently found in hysteria, locomotor ataxy, muscular atrophy, lead poisoning, and spinal irritation. In all of these diseases, galvanization of the sympathetic proves to be of essential service.

3. Cerebral hyperæmia. This condition is associated with and is a part of a large variety of diseases. Insomnia, hemiplegia, tic douloureux, many diseases of the eye and ear, as neuro-retinitis, nervous deafness and tinnitus aurium, are all more or less associated with cerebral hyperæmia, and all have been successfully treated by galvanization of the sympathetic.

4. Disorders of the vasa-motor nerves. Under this head may be included some cases of deficient circulation, cutaneous hyperæsthesia, and certain diseases of the skin.

5. Functional diseases of the digestive and genital apparatus. Galvanization of the sympathetic in these conditions seems to work, partly at least, by reflex action, and partly, also, by the influence which the spinal cord and pneumogastric receive during the applications.

It is scarcely necessary to remark that the exclusive use of galvanization of the sympathetic is indicated only in exceptional cases. It is to be employed in connection or alternation with general electrization and galvanization of the brain, spinal cord, and periphery. A noteworthy advantage of this method of treatment in those cases for which it is of service is the comparatively short time required for its employment.



FIG. 1.

Galvanization of the Sympathetic.



FIG. 2.

Galvanization of the Sympathetic, including the Pneumogastric.

(Besides these, there are a number of other positions of the electrodes by which the Sympathetic can be demonstrably affected.)